UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
WASHINGTON, D. C.
H. H. BENNETT, CHIEF
W. C. LOWDERMILK, ASSOCIATE CHIEF

ADVANCE REPORT

on the

SEDIMENTATION SURVEY OF HIGH ROCK RESERVOIR
SALISBURY, NORTH CAROLINA

May 18, 1935 - October 25, 1935

by

D. Hoye Eargle

Hydrodynamic Studies
Division of Research
SCS-SS-10
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Salisbury, North Carolina

GENERAL INFORMATION

Location: State: North Carolina (fig. 1).
Counties: Rowan, Davidson, and Davie.
Distance and direction from nearest city: The dam is 14 miles airline southeast of Salisbury, N. C.
Drainage and backwater: Yadkin River. The more important tributaries on which backwater is impounded are the South Yadkin River and Abbotts, Dutch Second, Flat Swamp, Crane, Swearing, and Grant Creeks.

Ownership: Carolina Aluminum Co., Badin, N. C., a subsidiary of the Aluminum Company of America, Pittsburgh, Pa.

Description of dam: The dam is a gravity-type concrete structure 60 feet high and 920 feet long, including the powerhouse on the east side. It is equipped with Stoney-type floodgates. The elevation of the crest line of the reservoir is 655.0 feet, local datum, or 624.1 feet, U. S. Geological Survey datum, above mean sea level. (Note: All subsequent elevations given in this report are based on local datum. For true elevation subtract 30.9 feet).

Date of completion: November 1927.

Average date of survey: August 1935.
Age to date of survey: 7.8 years.

Length of lake (original and present): 26.6 miles from the dam to the head of backwater along the thalweg of the Yadkin River.

Area of lake at crest stage: (determined by this survey)

	Acres
Original - - - - - - - - - -	15,886 1/
Present - - - - - - - - - -	15,833 (approximate)

Note: Continuous shore line was remapped only in the 5-mile section of the reservoir surveyed by the contour method (see accompanying reservoir map) where the thickness of sediment precluded the use of the range method requiring penetration to old bottom with the silt sampler.

1/ Data supplied by the Carolina Aluminum Co. give the original area as 16,100 acres.

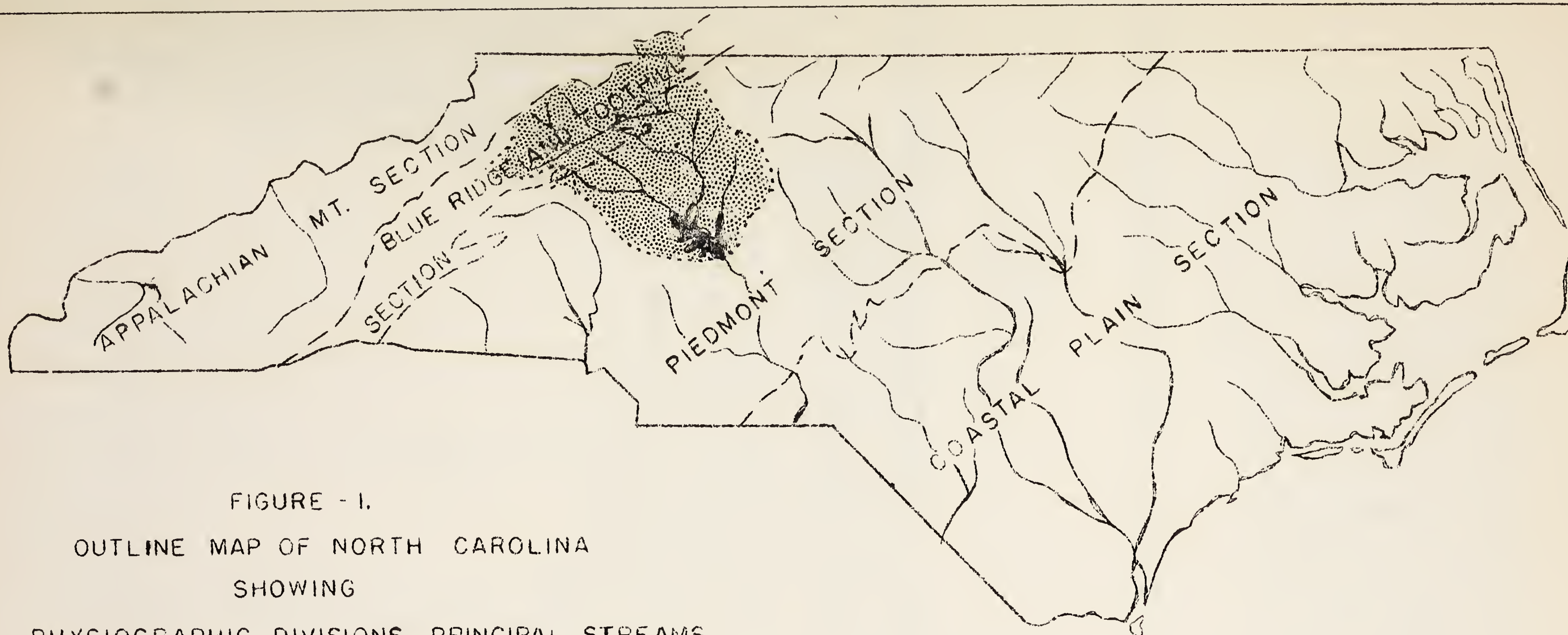


FIGURE - I.

OUTLINE MAP OF NORTH CAROLINA

SHOWING

PHYSIOGRAPHIC DIVISIONS, PRINCIPAL STREAMS,

THE LOCATION OF HIGH ROCK RESERVOIR

AND WATERSHED

WATERSHED OF HIGH ROCK RESERVOIR

HIGH ROCK RESERVOIR

SCALE STATUTE MILES

0 30 60 90 120

The area of this section has been decreased about 53 acres by the accumulation of silt deposits above crest level. Along the remainder of the Lake shore the crest line was remapped only where extensive changes had obviously taken place. Elsewhere it was evident that increase in area by wave erosion had practically compensated for decrease through accumulation of delta and lateral deposits above crest level. Thus, the amount of decrease in the total lake area is probably not far from the 53 acres measured in the contoured section, which would give a present area of 15,833 acres.

Storage capacity at crest stage: (determined by this survey)

	Acre-feet
Original - - - - - - - - - - - - - -	289,432 2/
Present - - - - - - - - - - - - - -	275,516
Loss by silting - - - - - - - - -	13,916

General character of reservoir basin: High Rock Reservoir occupies an elongate S-shaped section of the valley of the southeastward-flowing Yadkin River. The shore line of the reservoir is very irregular, especially in the lower half, where water is impounded in a large number of tributary valleys.

The location and length of each of the principal tributary arms of the reservoir are given in table 1.

Table 1.--Locations and lengths of tributary arms of High Rock Reservoir.

Stream	Distance from dam	Length
	(Miles)	(Miles)
Flat Swamp Creek...............	0.51	5.76
Panther Creek..................	0.85	1.33
Abbots Creek...................	2.56	13.45
Dutch Second Creek.............	3.69	6.11
Crow Creek.....................	5.21	1.35
Crane Creek....................	5.78	5.21
Swearing Creek.................	7.20	4.36
North Potts Creek..............	11.27	1.90
South Potts Creek..............	11.27	1.52
Grant Creek....................	17.05	2.32
South Yadkin River.............	19.91	5.01

2/ This is total capacity. The figure for usable storage above the lower limit of draw-down given by the Carolina Aluminum Co. is 11,100,000,000 cubic feet, or approximately 255,000 acre-feet.

Massive granites underlie the reservoir throughout its length except in the lower 4 miles, where they give place to a series of rhyolitic rocks, volcanic breccias, tuffs and slates, compressed into steep northeastward-trending folds. High Rock Dam is located in the narrow watergap cut by the Yadkin River through Flat Swamp Mountain, a long ridge of rhyolite which because of the superior resistance of this rock to erosion stands as a monadnock approximately 200 feet above the surrounding country.

The structure of the volcanic rocks is reflected in the drainage pattern of most of the tributaries of the lower part of the reservoir, the streams following, in general, the northeastward strike of the rocks, but occasionally turning at right angles to follow prominent joint systems for short distances. The resulting parallelism and alinement of tributary arms is well illustrated by Flat Swamp and Panther Creek arms, on opposite sides of the main basin near the dam (see reservoir map)

The floor of the reservoir basin consists predominantly of the submerged original flood plain, which ranged from 600 to 5,000 feet in width. The channel of the Yadkin was comparatively shallow and had an average gradient of 1.7 feet per mile from the head of backwater to the mouth of Crane Creek, 5.78 miles above the dam, or, roughly, through the granite area of the basin. Prior to submergence the only shoals in this reach of the river were at Trading Ford, about 14 miles above the dam, where relatively resistant granite cropped out in the stream bed. Likewise, resistant granite is responsible for the narrows about 15 miles above the dam, where the lake is only 650 feet wide, compared to average widths of 1,750 and 2,600 feet above and below the constriction, respectively. The main line of the Southern Railway and U.S. Highway 29 cross the river at this narrows.

The flood-plain floor of the basin first appears about 1 mile above the dam, at the head of the narrow gorge in which the dam is located, and widens rapidly to an average width of 5,000 feet for the next 2.5 miles. In this segment the flood plain consisted of two distinct levels, the first bottom and the second bottom, with average elevations of 615 and 625 feet, respectively. Above the mouth of Abbotts Creek the second bottom appeared only as occasional remnants.

Average widths and elevations of the flood plain above Abbotts Creek are given in table 2.

Table 2.--Widths and elevations of the Yadkin River flood plain above Abbotts Creek, High Rock Reservoir.

Location	Average width (feet)	Average elevation (feet)
Abbotts Creek to Crane Creek	3,500	625
Crane Creek to Swearing Creek	3,600	630
Mouth of Swearing Creek	2,000	635
One mile below Potts Creek	5,000	643
Mouth of Potts Creek	3,800	645
Potts Creek to narrows at U.S. Highway 29	2,600	650
Narrows	600	-
Narrows to mouth of Grant Creek	1,800	650 plus
Above mouth of Grant Creek	1,400	655 plus

Natural levees about 5 feet high rose above the general level of the flood plain along many reaches of the Yadkin River. Below the narrows they are entirely submerged but above the narrows they stand partly above crest level and thus appear at spillway stage as chains of narrow, elongated islands.

For about 1 mile above the mouth of Grant Creek most of the flood plain stands above spillway crest level, only the back-channels between the natural levees and the valley sides being submerged at crest stage. For the remaining distance to its limit upstream (8.5 miles on the Yadkin River and 7 miles on the South Yadkin) backwater is confined to the main channel and to short reaches of numerous smaller tributaries.

The tributaries of the Yadkin show essentially the same features as the main stream but on a scale proportional to their size. Those of the lower part of the reservoir, where the strike of the rocks determines the courses of the streams, have narrow V-shaped valleys; and those of the granite area above, as well as those in areas of less resistant slates, have wide flood plains. The larger tributaries have low gradients, and backwater extends several miles up their valleys, (table 1).

The width of the original channel of the Yadkin is given by sections in the following tabulation:

Distance from dam. (Miles)	Average width (Feet)
0 to 1.9	600
1.9 to 3.8	1,000
3.8 to 6.6	600
6.6 to 13.2	425
13.2 to 17.0	600
Above 17.0	300

The average depth of the original channel ranged from 10 to 20 feet below the level of the flood plain throughout the lower part of the basin, but was slightly less near the upper end. The channel for the most part had a flat bottom and steep sides.

The gradient of the original channel is summarized in table 3, based on measurements from an unpublished drawing in the files of the Carolina Aluminum Co.

Table 3.--Gradient of the original channel of the Yadkin River in High Rock Reservoir.

Distance from dam	Length of section	Average gradient
Miles	Miles	Feet per mile
0.00	-	-
0.38	0.38	13.16
1.97	1.59	6.29
6.14	4.17	2.40
13.24	7.10	1.41
13.60	0.36	13.89
15.80	2.20	2.27
18.38	2.58	1.94
21.86	3.48	1.44
26.63	4.77	1.05
Average for reservoir		2.25

The two sections with gradients of more than 13 feet per mile were distinct river rapids before construction of the dam. The rapids 13.6 miles above the dam was at the site of the historic Trading Ford.

The low average gradient of the river, together with the considerable width of flood plain, made it possible to impound a reservoir of large capacity by a comparatively low dam.

Former silt surveys: No silt surveys of High Rock Reservoir had previously been made. However, W. W. Ashe (1, p. 22)[3] estimated that

3/ Numbers in parenthesis refer to Literature Cited, p. 23.

850 pounds of soil per acre of watershed was carried annually by the Yadkin River near Salisbury. This was recalculated by the U. S. Engineers (5, p. 49) to 15.2 acre-feet per year per 100 square miles of watershed, a much lower figure than the 45.4 acre-feet determined by this survey from actual sedimentation measurements.

Area of watershed: 3,930 square miles (4, p. 93).

General character of watershed:

Physiographic setting.--The watershed of the Yadkin River above High Rock Dam is a rudely rectangular area lying mainly in northwestern North Carolina but extending a short distance into southwestern Virginia. (fig. 1). It is confined principally to the Piedmont Province, characterized by a submaturely dissected peneplain with moderate relief, although the extreme headwaters lie in the Blue Ridge Province and about 30 percent of the area, including part of the Piedmont, is typically mountainous.

Geology.--The extreme southeastern portion of the watershed, comprising a strip about 4 miles in width, is underlain by metamorphic slates, schists, and volcanic rocks, typical members of the so-called "Carolina slate belt" of the eastern Piedmont region. This belt is succeeded to the northwest by an igneous complex, known as the "Carolina granite belt", which within the area of the watershed averages about 20 miles in width. The complex is composed predominantly of medium-to coarse-grained granite and diorite, penetrated by several varieties of acidic and basic dikes. In the remainder of the watershed to the northwest, comprising about 75 percent of the total area, the chief formations are micaceous schists and gneisses of Archean age with which are associated considerable masses of both basic and acidic igneous rocks. There is no essential distinction between the rocks of the Blue Ridge and Piedmont sections of the drainage area.

Deep weathering of bedrock characterizes much of the watershed, the saprolite or "rotten rock" extending to maximum depths of 100 feet below the surface. Exceptions occur in the mountainous and semimountainous sections where accelerated erosion has removed the accumulated weathered material, or where the conversion of exceptionally resistant rocks to soil and subsoil has lagged behind normal soil removal. Exceptions also occur in the less rugged Piedmont where occasional extensive bodies of little fractured granitic rocks have escaped deep weathering and appear either as monadnocks standing above the general level or as bare rock surfaces flush with the ground.

Topography.--The headwaters of the Yadkin River have dissected the steep slope of the Blue Ridge escarpment into narrow V-shaped gorges separated by sharp, eastward-plunging, generally parallel ridges. The escarpment is about 2,000 feet in height, ranging from an elevation of more than 3,500 feet along the crest to about 1,500 feet at its base. The mountain front meets the Piedmont surface with a sharp topographic break except for occasional transitional foothills.

The most important foothills in the High Rock drainage area are the Brushy Mountains, a northeastward-trending range of peaks and ridges with a maximum elevation of 2,500 feet which gradually descend northeastward to merge with the general Piedmont level at the Yadkin River east of Elkin, N. C. The highest of these mountains form the divide between the Yadkin drainage area on the northwest and the Catawba and South Yadkin drainage areas on the south and southeast, respectively. To the northeast, however, both slopes of this range are drained by the Yadkin.

The considerably larger Piedmont section of the High Rock watershed has an average elevation of about 1,000 feet in its northwestern half and 700 feet in its southeastern half. It is a broad upland plain, submaturely dissected by streams which have cut valleys 50 to 100 feet below the general level. The interstream areas are gently rolling, but near the streams the slopes are steeper. Rising above the level of the peneplain are occasional monadnocks, such as Pilot, Dunn's and Flat Swamp Mountains composed of quartzite, granite, and rhyolite, respectively.

The gradient of the Yadkin River from its source to the head of High Rock Reservoir is given by sections and in approximate figures in table 4.

Table 4.--Gradient of the Yadkin River above High Rock Reservoir.

Reach	Length (Miles)	Total fall (Feet)	Gradient Feet per mile)
Headwaters to Patterson, N. C.....	15	2,250	150.0
Patterson, N. C. to N. Wilkesboro, N. C....................	32	316	9.9
N. Wilkesboro, N. C. to the Great Bend.....................	55	189	3.4
Great Bend to mouth of the South Yadkin....................	60	135	2.3
Average for total length	162	2,890	17.8

Soils.--Significant data on the types, erosion conditions and relative extent of the principal soils of the High Rock watershed are given in table 5. The soil series in each physiographic section are arranged as nearly as possible in decreasing order of erodibility. As accurate surveys for the entire watershed are not available the figures on areal extent are only approximate.

Erosion conditions.--The Piedmont section of the watershed is characterized by moderate to severe sheet and gully erosion (table 5). Because the soils were originally deep and fertile, the gentle slopes easily cultivated, and the climate favorable, most of this land was cleared for farming more than 100 years ago. Now, owing to excessive erosion induced by poor farming practices on highly erodible soils, and because of reduction of soil fertility by continuous planting to soil-depleting crops, much of the land has been left idle and exposed to further erosion until partly reclaimed by inferior second-growth forests.

In the mountainous sections of the watershed erosion is not so severe as in the Piedmont, owing partly to the much larger proportion of forested land and partly to the nature of the soils. The principal soil in the mountainous area is the highly absorptive and porous Porters loam, on which slopes up to 50 or 60 percent have been cultivated with only moderate soil loss. Furthermore, much of the area not covered by this unusually stable soil consists either of coarse-textured soils containing gravel and boulders, also stable, or of bare rock.

Table 5.--Principal soil types of the High Rock watershed.

Series	Principal types	Parent material	Erosion	Relative Extent (Percent)
Piedmont section:				
Wilkes............	Sandy loam........	Granite and gneiss.	Very severe... sheet, mod. gullying.	*
Helena............	Sandy loam........	Granite and gneiss	Very severe... sheet, mod. gullying.	*
Iredell (on slopes over 4%).	Loam to sandy..... loam.	Basic rocks	Very severe... sheet, slight gullying.	5
Cecil.............	Coarse sandy...... loam to heavy clay.	Granite and gneiss.	Severe sheet.. and gully.	54
Appling...........	Sandy loam to..... fine sandy loam.	Granite and gneiss.	Severe sheet.. and gully.	3
Mecklenburg.......	Loam, clay loam... and fine sandy loam.	Basic rocks	Moderate to... severe sheet and gully.	*
Davidson..........	Clay loam.........	Basic rocks	Moderate to... severe sheet and gully.	2
Georgeville.......	Silt loam, silty clay loam.	Slate, volcanic rocks	Moderate to... severe sheet and gully.	6
Madison...........	Loam, gravelly.... loam.	Mica schist, quartz-mica schist.	Severe sheet.. and gully.	*
Herndon...........	Silt loam.........	Slate, volcanic rocks	Moderate sheet and gully.	*
Durham............	Sandy loam, fine sandy loam.	Granite and gneiss.	Moderate sheet and gully.	4
Alamance..........	Silt loam.........	Slate, volcanic rocks	Moderate sheet and gully.	3

* Included in Miscellaneous.

Table 5.--Principal soil types of the High Rock watershed.--Continued.

Series	Principal types	Parent Material	Erosion	Relative Extent
				Percent
Mountain section:				
Talladega.........	Loam to silt...... loam.	Mica schist, talc schist	Very severe...	1
Chandler..........	Loam to silt...... loam.	Mica schist, talc schist	Very severe	1
Ashe..............	Stony loam........	Granite and gneiss.	Moderate to... slight.	2
Porters...........	Loam to stony..... loam	Granite and gneiss.	Moderate to... slight	8
Congaree (valley.. bottoms of both sections).	Fine sandy loam, silt loam.	Alluvium....	Little or..... none.	6
Miscellaneous				5
			Total.............	100

Land use:--The division of the watershed between the principal land uses is approximately as shown in table 6.

Table 6.--Land use in the High Rock watershed.

	Mountain Section	Piedmont Section	Entire Watershed
	(Percent)	(Percent)	(Percent)
Forest................	90	45	59
Cultivated............	8	50	37
Pasture...............	2	5	4

The principal forest species of the mountains are: chestnut, white, red, and black oaks, poplar, spruce pine, white pine, maple, beech, mountain laurel, and rhododendron; and of the Piedmont: red, white, and post oaks, hickory, shortleaf pine, maple, and some dogwood, locust, persimmon, walnut, cedar, poplar, sweetgum, sassafras, and mimosa.

Important crops of the mountain section are vegetables, fruit, corn, tobacco, hay, oats, rye, wheat, buckwheat, and potatoes. Cultivation is generally restricted to the gentler slopes and valley bottoms, though some of the steeper slopes are planted to field crops, orchards, and vineyards.

In the extensively cultivated Piedmont the principal crops are corn, cotton, tobacco, wheat, oats, rye, peas, soy beans, sorghum, peanuts, truck crops, and orchards. The important cash crops are cotton in the lower part and tobacco in the upper part of the Piedmont section.

Pature land is of limited extent in the Piedmont section, chiefly because few livestock are included in the agricultural economy of the region. In the mountain section pasturing is restricted by the rough topography, although the growth of native grass during the whole grazing season, resulting from more abundant summer rains, encourages pasturing of the rounded summits and some of the steeper slopes.

Mean annual rainfall:

	Inches
Average------------	47.78
Range--------------	41.69 at High Point (El.966)
to	53.37 at Browers (El.1,950)

Note: The above figures are based on U. S. Weather Bureau records at 8 stations in or near the High Rock watershed.

Inflow into reservoir: Table 7 was compiled from all available data on discharge of the Yadkin River near High Rock Reservoir.

Table 7.--Discharge of the Yadkin River at High Rock and Salisbury, N. C.

Station	Date	Discharge	
		Second-feet	Acre-feet per year
High Rock, N. C.	Period: 1919-1923		
Maximum.........	1921, July 21.......	1/ 104,000	
Minimum.........	1923, Oct. 17-19....	1,170	
Average.........	1920-1923.......	5,460	3,952,860
Salisbury, N. C...	Period: 1895-1909 1911-1923		
Maximum.........	1916, July 18.......	121,000	
Minimum.........	1897, Sept.20....... Oct.5, Nov.22, 26	2/ 900	
Average.........	1896-1923.......	5,150	3,728,430

1/ During the flood of July 18, 1916 a maximum discharge of 184,000 second-feet was recorded.

2/ On August 30, 1925 a minimum discharge of 700 second-feet was recorded.

Floods.--Most of the floods in the upper Yadkin watershed have been caused by excessive precipitation characteristic of the tropical hurricanes which occasionally pass over this section of North Carolina. From written accounts it seems that heavy rains falling on saturated soils, or intense rains of long duration, are the principal factors contributing to excessive run-off.

The flood of 1916, which produced the highest stage in the Yadkin River since the gage was established near Salisbury, followed a severe tropical storm on July 15, during which intense precipitation fell on ground already saturated by another tropical storm of July 9-10. On July 15, 1916 at Altapass, N. C., 22.22 inches of rain fell in 24 hours, the highest precipitation in a 24-hour period on record for any station east of the Sierra Nevada of California.

Floods in August 1908, September 1928, and October 1929, were also caused by tropical storms.

Flood damage along the Yadkin River involves principally the loss of crops and livestock and damage to railroad and highway bridges and fills. Occasionally small power plants, cotton mills, and villages, as well as sections of some of the larger towns, are flooded. However, most of the larger towns, transportation routes, and agricultural lands are located on interstream areas, so that flood losses have been comparatively low. Regulation of the river by power reservoirs has also prevented recurrence of many of the former losses.

The dates and estimated discharges of important floods on the Yadkin River near Salisbury between November 1927 (the date reservoir storage began) and January 1935 are listed below. The discharge figures were estimated by adding to the flow of the Yadkin River at Yadkin College that of the South Yadkin at Cooleemee and increasing the sum 15 percent for flow from the intervening drainage area (3. pp. 154-155).

Date			Discharge (Second-feet)
1927	Dec.	5	26,400
		5	27,800 (peak)
1928	Aug.	12	37,700
		18	63,700
	Sept.	7	45,600
		20	32,600
1929	Mar.	1	32,000
		6	23,700
	Oct.	3	83,400
1932	Oct.	18	63,500
	Nov.	2	35,000
1934	Mar.	4	30,000
	Dec.	2	30,500

Evaporation: The data in table 8 are based on records of the only 3 stations in North Carolina at which evaporation has been measured:

Table 8.--Evaporation at 3 North Carolina stations.

Station	Installation	Length of record	Mean annual evaporation
		(Years)	(Inches)
Chapel Hill, N. C........	Land pan.....	8	41.48
Lake Michie, Durham, N.C.	Lake pan.....	3	44.11
Lake Tallassee, Badin,N.C	Lake pan.....	4	54.73

Protection from winds is thought to account for the relatively low figure for the Chapel Hill station.

Power development: The installed power equipment consists of three units rated at 11,000 kilowatts each, giving a total of 33,000 kilowatts or approximately 44,100 horsepower. The operating head at spillway stage is 60 feet and the draft under full plant operation is 7,350 cubic feet per second. The average seasonal draw-down is 18 feet (7-year average).

HISTORY OF SURVEY

The sedimentation survey of High Rock Reservoir was made during the period May 18 to October 25, 1935, by the Southeastern Reservoir Party, Section of Hydrodynamic Studies, Division of Research, under the immediate direction of D. H. Eargle. Other members of the party were L. M. Seavy, Assistant Chief, G. A. Zwerner, E. H. Moser, Jr., W. G. Shannon, and A. B. Taylor. Computations of silt volumes and reservoir capacities were under the direction of Mr. Zwerner.

Original and present capacities and silt volumes were determined in a 1,200-acre section, including the area of heaviest sediment accumulation, by the contour method and in the remaining 14,700 acres of the reservoir by the range method (2. pp.129-137). A total of 197 ranges was sounded and spudded.

Primary control was established by expanding a triangulation net from three chained base lines over the entire length of the main body of the reservoir and the wider parts of the tributary arms. Secondary control, consisting mainly of range ends and cut-in stations, was established by triangulation and stadia from points in the primary net. Elevations of points on the lake bottom were determined by soundings in submerged areas and by levels in exposed areas.

The contoured area (see reservoir map) was mapped on a scale of 400 feet to the inch and a contour interval of 1 foot. The same scale was used in the narrower segments of the area surveyed by the range method but the wider segments were mapped on a scale of 1,000 feet to the inch.

The original reservoir basin had been mapped by plane table in 1921 by the Tallassee Power Co. (later the Carolina Aluminum Co.) on a scale of 400 feet to the inch and contour intervals of 10 feet between the 600 and 630 contours and 5 feet between the 630 and 655 (crest level) contours. The contours on this map had not been extended across the bed of the river; hence, in order to determine the original capacity of the segment of the lake mapped by the contour method, it was necessary to reconstruct original contours in the channel. This was done by interpolating between old channel elevations determined by spudding on ranges 62-63 and 120-121, at the upper and lower ends of the segment, respectively, and by spudding to the original channel bottom at several points within the contoured area.

The original and present areas of the reservoir were planimetered from the crest line on the original map, except where extensive deposition or wave erosion called for remapping the shore line to obtain the present area.

ACKNOWLEDGMENTS

The Soil Conservation Service acknowledges the generous cooperation of J. W. Rickey, chief hydraulic engineer of the Aluminum Company of America, Pittsburgh, Pa., and S. A. Copp, general superintendent, D. Clark, chief engineer, and A. J. Rice, engineer of the Carolina Aluminum Co., Badin, N. C., in loaning original maps of the basin and in giving valuable information and advice during the survey.

W. D. Lee, cooperative agent in soils studies of the Soil Conservation Service at High Point, N. C., furnished information on soils, erosion conditions, and land use of the watershed.

SEDIMENT DEPOSITS

Character of sediment:

Texture.--The sediment of High Rock Reservoir shows all gradations from boulders, pebbles, and coarse sand in the upper reaches to fine-grained unctuous mud in the lower basin. In the first few miles below the head of backwater the deposits consist of boulders, pebbles, and sand in midchannel and fine sand and sandy silt near the banks. Bars of sand and gravel in the channel differ little if at all from those in the unregimented stream above the head of backwater.

In the main channel near the mouth of the South Yadkin the sediment consists of comparatively clean sand near the center but grades laterally through silty sand to sandy micaceous silt interstratified with coarse sand and deposits of organic matter near the banks.

The nature of the sediment in the main delta area was determined from spud samples on a range extending directly across the lake from a point 700 feet downstream from the mouth of Grant Creek. The results of these spuddings, given in table 9, illustrate the stratification

of the midchannel deposits, the lateral gradation to finer sediment near the shores, and the concentration of sediment on the inside (north side) of a wide bend in the river.

Downstream from the above range the sediment becomes progressively finer. The point nearest the dam at which sandy silt was found is on range 400-401, immediately above the mouth of Potts Creek. Farther downstream the sediment consists of uniform gray silt of very fine texture.

Table 9.--Results of spuddings on range across Yadkin River below Grant Creek.

Observation	Distance from south shore (Feet)	Water depth (Feet)	Sediment: Character	Sediment: Thickness (Feet)
1.	31	2.0	Fine clayey silt.......	0.2
2. (in back-channel slough)	211	5.8	Fine clayey silt.......	0.5
3.	422	2.6	Fine silt..............	0.5
			Sandy silt.............	1.3
			Total................	1.8
4.	559	3.7	Fine silty sand........	4.0
5.	778	14.4	Silty sand.............	0.4
			Clean sand.............	1.0
			Total................	1.4
6. (Midchannel)	988	12.0	Silty sand, leaves.....	0.6
			Clean sand.............	0.2
			Silty sand.............	0.4
			Clean sand.............	0.6
			Silty sand.............	0.4
			Clean sand.............	0.9
			Total................	3.1
7.	1,167	11.2	Clayey silt............	3.3
			Coarse sand with....... leaves.	1.4
				4.7
8. (North edge of channel)	1,300	8.8	Fine silt..............	5.8

On the tributaries essentially the same textural features occur as on the main river, viz., interstratified sand and silt in the channels and fine silt on the flood plains above the lower limit of draw-down, and extremely fine, oozy sediment at lower levels. In some

instances, however, tributary streams have carried coarse sediment well below crest level. For example, Grant and Potts Creeks have built large sand deltas through the upper two segments of their respective arms.

Color.--The sediment is generally dark gray when freshly exposed but becomes lighter in color on drying, the ultimate color depending principally on the content of organic matter and to a lesser extent on the content of iron minerals. After extended aeration the silt becomes dark reddish gray or brownish gray. The presence of many flakes of white mica or of a preponderance of sandy material also produces lighter colors. Sand in the channel in the upper part of the delta ranges from pure white to yellowish or reddish gray, the color depending on the amount of admixed fine silt and clay. In a few instances silt deposits rich in black minerals such as biotite mica, hornblende, and magnetite occur where the sorting effect of wave action has concentrated these minerals from the residual soil along the shores. Such concentrations were observed along the banks of North Potts Creek in segment 176.

Organic matter.--Accumulations of leaves and other plant remains intercalated in the sediment were detected in many parts of High Rock Reservoir. At the big bend in the river midway of the reservoir, on range 400-401, a leafy deposit several feet thick had been sealed in the silt, and when penetrated by the spud gave off large amounts of marsh gas. The flow of gas, accompanied by vigorous bubbling and spraying at the water surface, continued for at least 30 minutes.

Other evidence of buried organic matter was noted on the south shore of the reservoir near the bridge of U. S. Highway 29. During a draw-down a huge silt deposit on the south side of the channel was exposed (fig.2A), revealing a surface covered with miniature domes or "blisters". Each blister was separated from its neighbors by a sheath or collar of leafy matter, and all the collars were united in an irregular honey-comb pattern (fig.2B). When first observed these structures had been out of water several days and were extensively cracked. The cracks generally radiated from near the center of the blister, except in the case of one elliptical structure about 30 inches long, in which several long cracks extended across the blister parallel to the major axis.

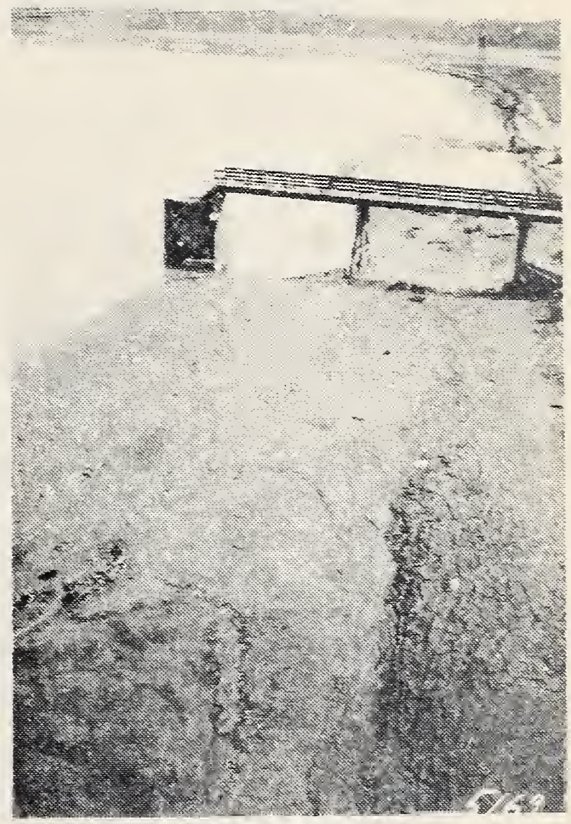
The blisters were unquestionably formed by the upward pressure of accumulating marsh gas resulting from the decay of buried organic matter, and the radiating cracks by drying and shrinkage of the exposed silt. The explanation of the enclosing sheaths of leafy matter is less clear, although they are obviously related in origin to the gas blisters. This particular manifestation of marsh gas in sedimentary deposits is unusual, and to the writer's knowledge has not been described elsewhere.

Distribution of sediment:

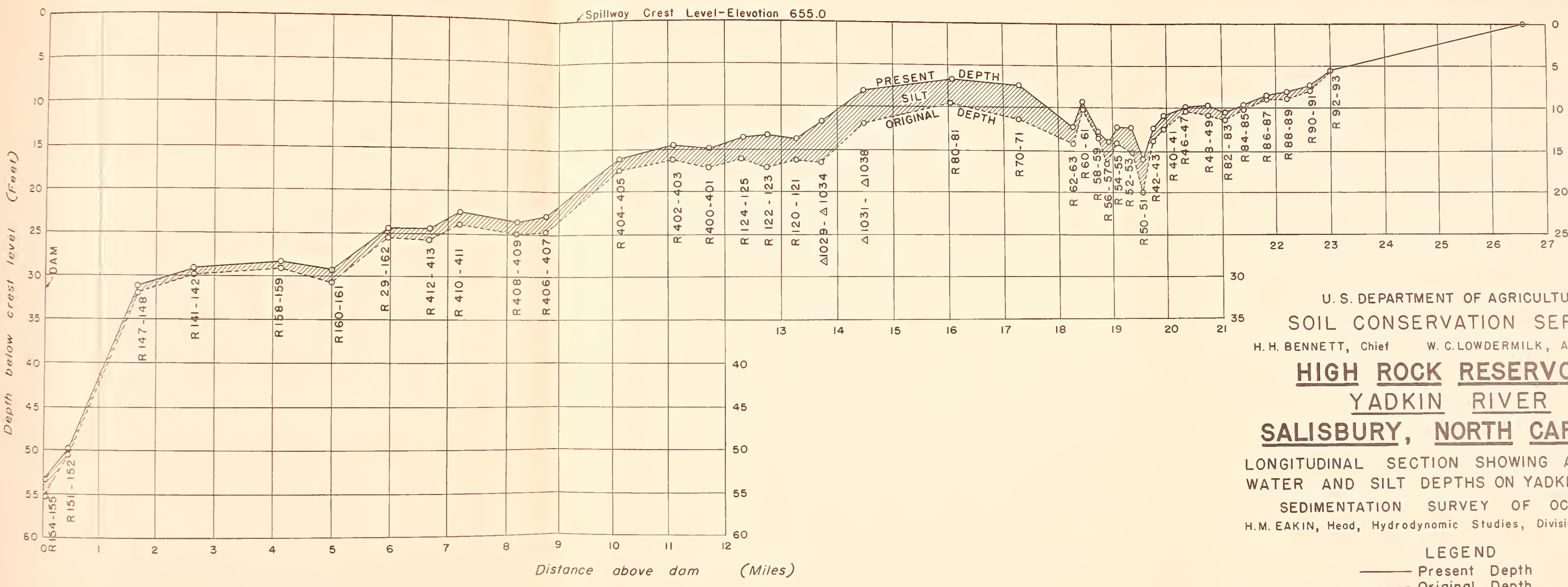
The distribution of sediment in various sections of High Rock Reservoir is brought out in table 10 and figure 3. The division between the "Delta section" and the "Lower section" is range 120-121, the lower end

Figure 2.

A. Large silt deposit along the south side of Yadkin River channel near U. S. Highway 29. Note how the silt is encroaching on the water intake of the pumping station for the Southern Railway. The water level was about 10 feet below crest when the picture was taken.



B. "Blisters" in silt caused by gas from buried vegetation, surrounded by collars or sheaths of leafy matter. South shore of High Rock Reservoir, near the bridge on U. S. Highway 29.



U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

H. H. BENNETT, Chief W. C. LOWDERMILK, Associate Chief

HIGH ROCK RESERVOIR

YADKIN RIVER

SALISBURY, NORTH CAROLINA

LONGITUDINAL SECTION SHOWING AVERAGE WATER AND SILT DEPTHS ON YADKIN RIVER

SEDIMENTATION SURVEY OF OCT., 1935

H. M. EAKIN, Head, Hydrodynamic Studies, Division of Research.

LEGEND

——— Present Depth

- - - - - Original Depth

////// Silt

0-1742

Table 10.--Distribution of sediment in High Rock Reservoir.

Section	Capacity			Sediment		
	Original	Present	Loss	Volume	Relation to original capacity of reservoir	Relation to total sediment in reservoir
	Acre-feet	Acre-feet	Percent	Acre-feet	Percent	Percent
Delta section:						
Contoured area..........	12,516	9,310	25.62	3,206	1.11	23.04
Yadkin River above contoured area.......	3,439	3,115	9.41	324	0.11	2.33
South Yadkin Ri ver....	1,678	1,530	8.85	148	0.05	1.06
Other tributaries......	860	590	31.34	270	0.09	1.94
Total...............	18,493	14,545	21.35	3,948	1.36	28.37
Lower section:						
Yadkin River below contoured area.......	166,431	159,201	4.34	7,230	2.50	51.95
Tributaries............	104,508	101,770	2.62	2,738	0.95	19.68
Total...............	270,939	260,971	3.68	9,968	3.45	71.63
Total for reservoir.......	289,432	275,516	4.81	13,916	4.81	100.00

of the contoured area, and is indicated on the reservoir map by the line A-A. Table 10 shows that the heaviest accumulation of sediment has occurred in the contoured area of the delta section. Although this area originally included only 4.32 percent of the total reservoir capacity, it has received 23 percent of the sediment. It has lost nearly 26 percent of its capacity as compared to 3.68 percent loss for the lower section and 4.81 percent for the entire reservoir.

A more detailed discussion of the distribution of sediment is given in the following paragraphs:

Sedimentation in the upper part of the reservoir:--In the upper few miles of the reservoir practically no true lake sediment has been deposited. On range 92-93, about 3.6 miles below the head of backwater on the Yadkin River, the channel has a hard rock bottom entirely free of sediment. Above this range the only deposits are sand bars and boulders such as might be found on any undisturbed stream in this region. The water level in this reach is raised less than a foot by the dam, and the regimen of the river only slightly disturbed.

On range 90-91, 1,450 feet farther downstream, clean sand is overlain by a thin deposit of sandy silt or silty sand, except in the thalweg of the channel where clean sand alone has accumulated. The fine sediment at this point is the first indication of other than normal river-channel sedimentation. Even these deposits are only temporary, having formed probably since the last high water.

On passing downstream from range 90-91 to the mouth of the South Yadkin, a distance of nearly 7 miles, the gradually increasing depth of ponded water is accompanied by a corresponding increase both in the depth of sediment and in the distinction between midchannel and lateral deposits. In midchannel the deposits consist of sand, in places overlain by a temporary deposit of sandy silt or silty sand. Near the banks the accumulations are thicker and finer-textured and are distinctly stratified into layers of different grain size.

On the South Yadkin arm of the reservoir essentially the same sedimentation features occur as in the reach of the Yadkin just described, although on the South Yadkin deposition takes place much nearer the head of backwater. On range 108-109, 1.7 miles below the head of backwater, spuddings revealed clean sand in the channel near the right bank and a thicker stratified deposit of silt, sandy silt, and silty sand near the left bank.

The maximum depth of sediment measured on the South Yadkin arm was 6.8 feet, on the inside of the bend on range 96-97. The deposit at this point consisted of slightly sandy silt containing organic matter near the bottom. Toward the opposite bank where the current is stronger only sand had been deposited.

The maximum average silt depth on the South Yadkin was 1.76 feet on range 44-45 immediately above the mouth of the arm.

Between the mouth of the South Yadkin River and the upper end of the main delta (about 2 miles downstream) there is a general increase in the amount of sedimentation, except in constricted sections of the channel or on the outside of bends where stronger currents have partly or wholly prevented deposition. For example, 4 spuddings near the outside of a bend on range 58-59, about 1 mile below the South Yadkin, revealed a rock bottom free of silt whereas near the opposite side a maximum depth of 5.1 feet of interstratified sandy silt, clayey silt, and organic matter had accumulated.

The effect of floods on sedimentation is especially apparent between the main delta and the mouth of the South Yadkin. Here silt-laden flood currents first feel the ponding influence of the reservoir and have left deposits several feet above crest level, especially on the inside of stream bends.

Several floods in the history of the reservoir have been of overbank magnitude in the upper reaches where backwater is confined to the river channel and have left deposits of sediments on the normally exposed flood plain. During such floods sediment previously accumulated in the main channel is swept further downstream, the sand and coarser material contributing to the growth of the delta, and the finer material continuing into the lower basin to form bottom-set beds.

Another feature attributable to floods, as well as to variations in water surface elevation produced by draw-downs, is the stratification of deposits in the upper part of the reservoir. The fluctuations in current velocity and carrying power accompanying rising and subsiding flood stages result in alternate deposition of coarse sandy sediment and finer silt and clay. Similar alternations are produced in the reach between the upper and lower limits of backwater, determined by maximum and minimum reservoir stages. The stratification so produced may be sharp or poorly defined, depending on the abruptness of the changes in sedimentation conditions.

Sedimentation in the main delta area.--The greatest accumulation of sediment in the reservoir occurs within the contoured section (table 10) which extends roughly from Grant Creek to a point 1.75 miles below the bridge on U. S. Highway 29. In this area the old flood plain as well as the main channel is generally submerged, and here inflowing currents are first checked sufficiently to permit much permanent sedimentation (fig. 4A). Even this far down the reservoir, deposits in the main channel are subject to further transportation during floods or periods of draw-down. At times of low discharge, however, the quantity of sediment brought in by tributary streams may be sufficient to clog the main channel and divert the river flow. A case in point was observed about 1,500 feet below the highway bridge during a draw-down of about 10 feet below crest, at which stage backwater is largely confined to the main channel. The small tributary flowing across the heavily silted flood plain at this point built a delta almost entirely across the channel of the Yadkin River.

Deposits in the channel shift from year to year as shown by photographs taken during every major draw-down by engineers of the Carolina Aluminum Company. Deposits on the flood plain, on the other hand, are increased each year and are removed only where incised by tributary streams (fig. 4B). The most rapid accumulation takes place on the inside of stream bends, on the leeward side of the natural levees, and in low areas of the submerged flood plain.

During periods of draw-down of as much as 5 feet practically all the flood plain above the narrows at the bridge of U. S. Highway 29 is out of water, and draw-downs of 10 feet or more expose most of the delta deposits below the narrows as well. The sediment in these areas is thus subject to repeated drying and consequent progressive compaction, which not only makes the deposits more resistant to scour by flood waters, but also considerably reduces their valume.

Sedimentation in the lower basin.--In the section of the lake below the delta deposition has been limited to extremely fine-grained sediment composed of silt and clay with some organic matter. The greatest thicknesses usually occur in the old channel, but a comparatively thin blanket of silt covers the old flood plain. The greatest thickness in the lower basin was found near the toe of the delta on range 122-123, about half a mile below the contoured section, where a maximum thickness of 10.0 feet and an average thickness of 3.7 feet was obtained. Downstream from this range the average silt thickness decreases gradually and uniformly to 0.6 foot on range 151-152, 3,500 feet above the dam, but increases again to 1.8 feet on range 154-155, 500 feet above the dam. Sedimentation in the lower basin differs from that of the delta area chiefly in the greater homogeneity and lack of stratification of the deposits.

Sedimentation in the tributary arms.--The depth of deposits in the tributary arms of the upper part of the reservoir, above and including Potts Creek, is generally greater than in the main basin, but in the tributaries below Potts Creek the deposits are considerably thinner. Average sediment thicknesses on ranges across the upper tributaries range from 0.5 to 3.4 feet, whereas those on tributaries below Potts Creek are generally less than 0.5 feet. The maximum deposition for all tributaries has occurred on Grant Creek, where the average thicknesses on the four ranges, beginning at the lowest range, were 1.0, 1.3, 1.9, and 3.4 feet, respectively. Sedimentation in the tributary arms in general duplicates that of the main body of the reservoir on a reduced scale. Stratified delta deposits near the head of backwater give way downstream to fine-textured homogeneous bottom-set beds.

Origin of sediment:

The sediment entering a reservoir may be considered in two parts, (1) that which is supplied to the main stream and tributaries by run-off from the watershed, and (2) that which the streams obtain from bottom scour and lateral cutting in their own channels. In the

Figure 4.

A. Silt deposit on the old flood plain of Yadkin River at the mouth of Grant Creek. The grass-covered ridge in the near background is an old natural levee of the Yadkin River.

B. View of silt-covered flood plain of Yadkin River, about 2 miles east of U. S. Highway 29. Note the contact between reservoir silt and old flood-plain deposits, indicated by the white line.

case of High Rock Reservoir, flood plains and banks well protected by vegetation, lack of a meandering course conducive to lateral cutting, and resistant bedrock in the channel bottom all tend to make sediment from the second source an unimportant factor. A reconnaissance of the watershed, on the other hand, revealed two salient facts concerning the principal sources of the reservoir sediment.

It was first noted that there is a correlation between the character, amount, and distribution of sediment in the tributary arms and the texture and erodibility of the soil on the contributing watershed. Tributaries draining soils with a dense texture and a low dispersion ratio, as well as those draining rocky lands, were found to have comparatively small accumulations of sediment in their basins. On the other hand those tributaries which drain areas of loose-textured sandy soils, particularly the Cecil series, have a high rate of accumulation, especially in the delta or headward portion.

A second correlation exists between land use and the extent of silting. For example, the forested slopes of Flat Swamp Mountain, although much steeper than those in the watershed of any other tributary arm, have contributed a relatively small volume of sediment to the Flat Swamp Creek arm. This sediment has a high organic content, showing that it is derived largely from the forest litter on the slopes above. On the other hand, the extensively tilled loose-textured soil of the Grant Creek watershed, where the slopes are generally not excessive, has furnished sediment to the Grant Creek arm at an exceptionally high rate.

The following tabulation gives a summary of data relating to High Rock Reservoir, Salisbury, N. C.

	Quantity	Unit
Age 1/	7.8	Years
Watershed:		
Total area	3,930	Sq. Mi.
Reservoir:		
Original area at crest stage	15,886.03	Acres
Present area at crest stage	15,832.88	Acres
Original storage capacity	289,432	Acre-feet
Present storage capacity	275,516	Acre-feet
Original storage per square mile of drainage area	73.65	Acre-feet
Present storage per square mile of drainage area	70.11	Acre-feet
Sedimentation:		
Delta deposits) Bottomset beds)	Not measured separately	
Total sediment	13,916	Acre-feet
Accumulation per year average	1,784.1	Acre-feet
Accumulation per year per 100 square miles drainage area	45.4	Acre-feet
Accumulation per year per acre of drainage area	30.9	Cubic feet
Or, assuming average weight of 1 cubic foot of silt is 100 pounds	1.5	Tons
Depletion of storage:		
Loss of original capacity per year	0.62	Percent
Loss of original capacity to date of survey	4.81	Percent

1/ Storage began: November 1927.
Date of survey: May 18 - October 25, 1935.

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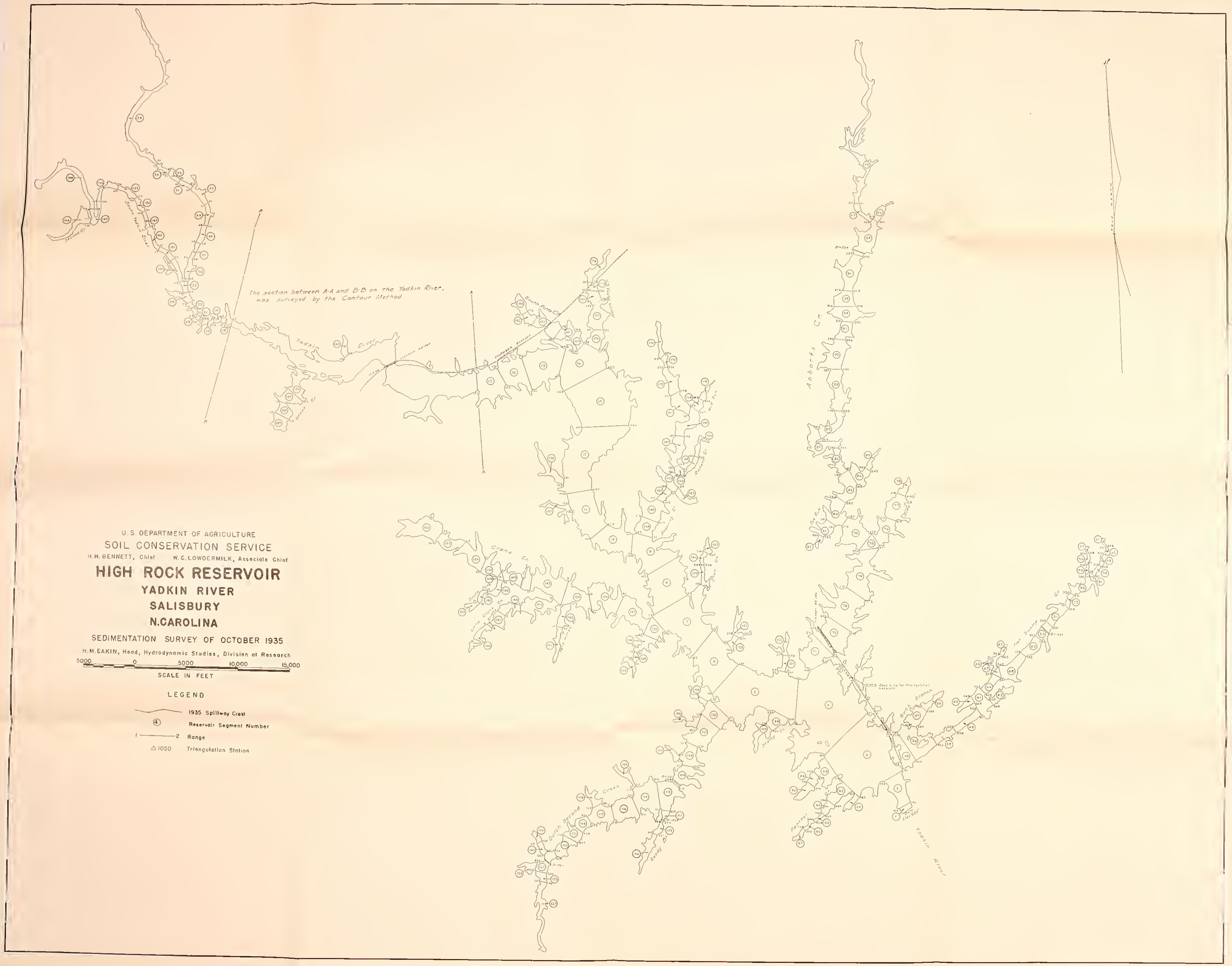

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N.CAROLINA
SEDIMENTATION SURVEY OF OCTOBER 1935
H.M. EAKIN, Head, Hydrodynamic Studies, Division of Research
5000 0 5000 10,000 15,000
SCALE IN FEET
LEGEND
1935 Spillway Crest
Reservoir Segment Number
Range
△1050 Triangulation Station
The section between A-A and B-B on the Yadkin River, was surveyed by the Contour Method.
Yadkin River
Abbotts Cr.
Crane Cr.
Dutch Second Creek